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VOLUME AND WEIGHT CHARACTERISTICS OF A TYPICAL DOUGLAS-FIR/WESTERN LARCH STAND, CORAM EXPERIMENTAL FOREST, MONTANA

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RESEARCH SUMMARY

An overmature Douglas-fir/western larch stand on the Coram Experimental Forest in Montana was skyline logged using three different cutting methods and four different levels of utilization.

Prior to harvest, the total volume of wood averaged 7,300 ft^3/acre (511 m^3/ha) and ranged from 4,400 to 15,000 ft^3/acre (308 to 1 042 m^3/ha) on the various cutting units. Fifty-seven percent of this was sound green material, the rest was dead or rotten. In addition, there was about 57 tons/acre (128 t/ha) of fine material including tree crowns, duff, and litter.

After harvest, the volume of wood remaining ranged from about 40 percent of the preharvest volume in conventional saw log utilization to under 20 percent where intensive utilization was practiced. Type of material and size of residues also varied by utilization treatment. Fine material increased from 3 to 10 tons/acre (7 to 22 t/ha) depending on utilization level.

The amount and condition of woody material and changes with harvesting on this typical site provide a basis for evaluating woody biomass conditions before harvesting is undertaken.

CONTENTS

More detailed summary tables are available from the Forestry Sciences Laboratory, Missoula, Mont.:

Request: "Appendix supplement to volume and weight characteristics of a typical Douglas-fir/western larch stand, Coram Experimental Forest, Montana."

INTRODUCTION

Currently there is a great deal of interest in increasing utilization from forest stands. This interest stems from growing demands for wood products and from a concern over impacts of logging residues on esthetics, recreation, and wildlife. As utilization has increased over the years, forest managers have also had to take into account the effects of removing more of the wood material from the site. Whereas large volumes of residues can pose management problems, removal of too much material could adversely effect the ecosystem.

In 1973, a comprehensive study was begun in an overmature high risk Douglas-fir/western larch (*Pseudotsuga menziesii* [Mirb.]/*Larix occidentalis* [Nutt.]) stand on the Coram Experimental Forest. The objectives of the Coram study were to determine the impacts of various cutting methods, utilization levels, and postharvest treatments. Some aspects considered were regeneration, nutrients, water and hydrology, microclimate, logging systems, and costs.

The object of this report is to summarize information on woody material before and after harvest. It is intended to give managers information on the amount and kinds of material in a typical Douglas-fir/larch stand and on changes under different types of cutting and utilization. In addition, basic data are summarized for those concerned about the effects of woody material on other aspects of the forest, such as soil water, nutrients, and fauna.

Basic volume and weight summaries are included in this report. A more detailed data appendix is available upon request.

DESCRIPTION OF STUDY

Location and Harvesting Specifications

The study area is located in the Abbott Creek drainage of the Coram Experimental Forest. It consists of six blocks (total 100.3 acres, 40.6 ha), with each cutting method being used on two blocks, as follows:

Blocks	
11 and 21	Shelterwood (SH) = leaving about half the volume and aiming toward good height and species diversity: 35.1 and 21.5 acres (14.2 and 8.7 ha).
12 and 22	Group selection (GS) cuts = all merchantable trees cut. Eight groups of 0.5 to 1.5 acres (0.2 to 0.6 ha) in each block: 7.5 and 6.0 acres (3.0 and 2.4 ha).
13 and 23	Clearcuts (CC) of 13.6 and 16.6 acres (5.5 and 6.7 ha).

The elevations range from about 3,900 feet (1 189 m) to 5,200 feet (1 585 m) and the aspect is generally east and southeast. Habitat type is mostly *Abies lasiocarpa/Clintonia uniflora*. Small sections of other types are also present. Control blocks were established adjacent to several cutting units (fig. 1). Each of the six blocks described was further divided into four utilization levels henceforth referred to as treatments.

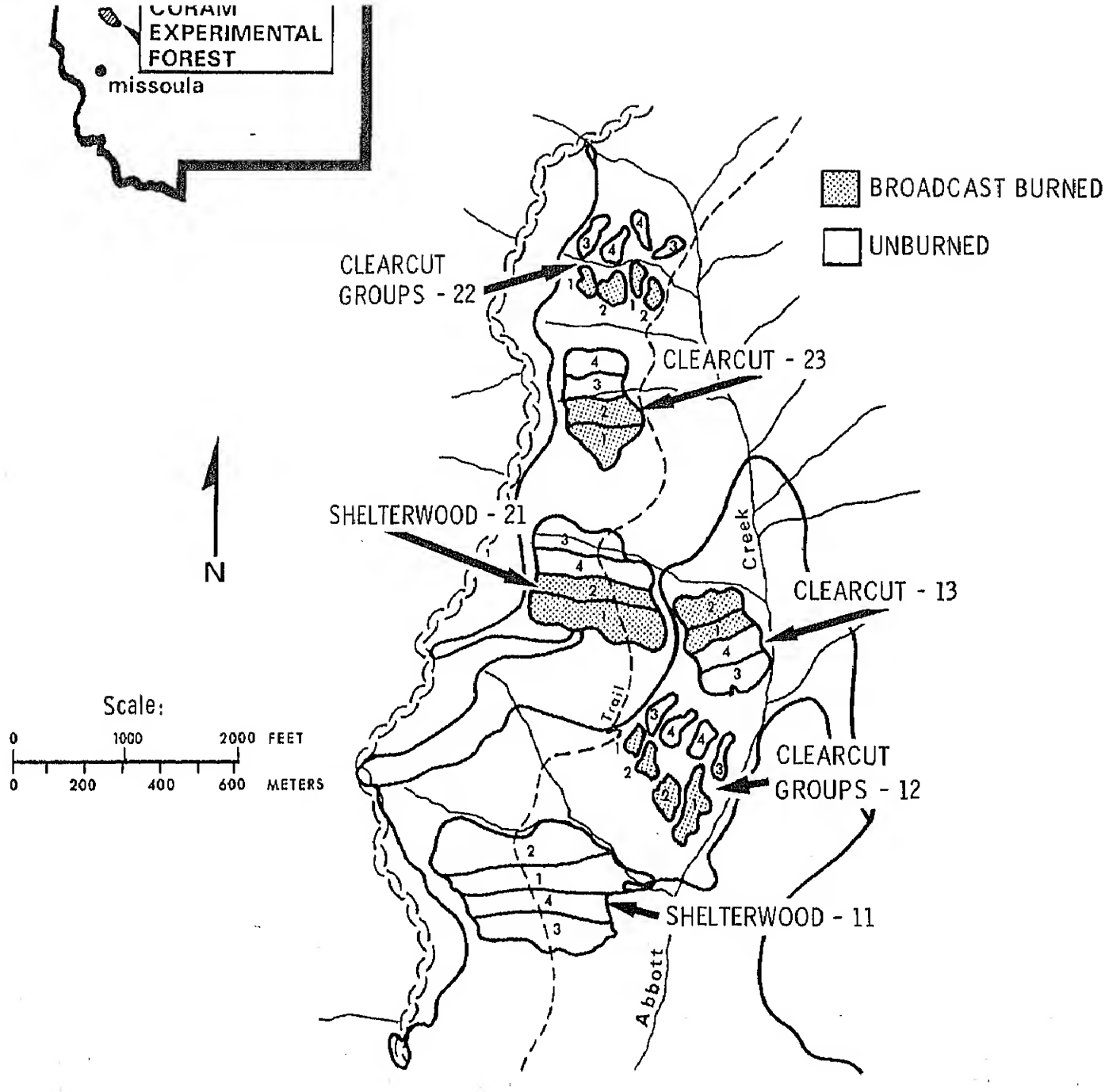

Figure 1.--Location of cutting blocks in Abbott Basin, Coram Experimental Forest. Timber harvested in 1974 and broadcast burned in Sept. 1975 (Artley and others 1978).

Treatments	Specification
1. Intensive tree (IT) utilization: utilization of all trees with a 5-inch (12.7-cm) d.b.h.	All material at least 8 feet (2.4 m) long with at least a 3-inch (1.62-cm) small end diameter was removed (this included trees down to a 5-inch [12.7-cm] diameter breast height [d.b.h.]). The area was burned after harvest.
2. Saw log (SL) utilization: saw log utilization standards	Trees down to a 7-inch (17.8-cm) d.b.h were cut, logs down to a 6-inch (15.2-cm) top diameter were removed, and the area was burned after harvest.
3. Near complete (NC) removal: removal of all material	All trees down to a 1-inch (2.5-cm) d.b.h. were cut and removed. The area was left as it was after harvest.
4. Intensive log (IL) utilization: close utilization of logs cut from trees 7 inches (17.8 cm) d.b.h. and larger	Trees down to 7-inch (17.8-cm) d.b.h. were cut, logs 8 feet (2.4 m) long with a diameter down to 3 inches (7.62 cm) were utilized. Remaining trees were protected as far as possible and left as advanced regeneration.

The preharvest (spring) field measurements at Coram were made in 1973 and 1974; the harvest was in the summer of 1974. Postharvest (autumn) measurements were taken from 1975 through 1977.

Measurement of Standing Trees

A 100 percent inventory of sawtimber trees (over 7.0 inches [17.8 cm] d.b.h.) was made on all cutting blocks before harvest and in shelterwood blocks after harvest. The preharvest tree data were processed by using the Region 1 (Northern Region) timber sale computer program to derive board foot volumes used in the timber sale preparation.

Smaller trees were measured on permanent plots, 10 plots per utilization level (40 per cutting block) and 50 plots per control area. Plots of 0.02 acre (0.0081 ha) were used to measure these smaller trees (poles, saplings, and seedlings).

Measurement of Down Woody Material, Litter and Duff

The down woody material was measured along transects using procedures described by Brown (1974), as follows:

Diameter at intercept of down material	Transect length
3 inches (7.62 cm) and larger	50 feet (15.24 m)
1 inch (2.54 cm) to 3 inches (7.62 cm)	10 feet (3.05 m)
0 to 1 inch (2.54 cm)	6 feet (1.83 m)

In the preharvest inventory, two transects were established from each permanent plot for a total of 20 transects per treatment. For postharvest measurements, one transect was established at each permanent plot and 20 were established at randomized nonpermanent grid points, for a total of 30 transects per treatment.

Duff and litter depths were measured at three points along the transect (1 foot, 6 feet, and 10 feet from the origin). Duff included decomposed material above the mineral soil up to the litter layer. Litter included all foliage, leaves, and other organic material that was still identifiable. Woody material on the litter surface was tallied on the transect as described.

Estimation of Crown Weights

Crown weights were calculated using equations developed by Brown (1978). These equations use tree species, diameter, and height to derive estimates of crown weight. Fractions of these crown weights in foliage and branchwood diameter size classes of 0 to 1/4 inch (0 to 0.63 cm), 1/4 to 1 inch (0.63 to 2.54 cm), and 1 to 3 inches (2.54 to 7.62 cm) were also determined using tables given by Brown and others (1977).

Sampling Errors

Percent errors were calculated for various preharvest and postharvest volume and weight components. Percent error is the sample standard error divided by the sample mean and expressed as a percent. Errors based on total samples were quite low, ranging from 3.7 to 7.6 percent. These low errors were expected because of the large number of samples taken. For individual wood components within each subtreatment, the error was higher, but was usually within the range expected, given the limited number of samples that could be made within each subtreatment and each cutting unit.

THE PREHARVEST STAND

The study site at Coram is typical of overmature Douglas-fir/larch sawtimber stands in western Montana. The stand reflects a history of factors such as fire, insects, disease, windthrow, and snow breakage. Over the 200 plus years of the stand these factors--plus topography and other site features--led to a patchy mosaic of different tree ages, sizes, and species. Number of trees and volumes vary considerably.

Wood 3.0 Inches (7.62cm) Diameter and Larger

The average volume for all woody material based on all samples in the study area was 7,318 ft^3/acre (512 m^3/ha). This is about the same volume as the average for overmature high risk stands in western Montana National Forests (table 1). There was considerable variation among individual cutting blocks and subtreatments, ranging from 4,400 ft^3/acre to nearly 15,000 ft^3/acre (308 to 1 042 m^3/ha). A summary of volumes for each cutting unit and subtreatment is presented in tables 2, 3, and 4.

Table 1.--*Volume of woody material for Douglas-fir and larch stands in western Montana National Forests, ft^3/acre (m^3/ha)*

Type material	Area		
	Coram study	Western Montana National Forest high risk sawtimber	
Standing green			
Sawtimber	3,706	3,927 to	4,510
Other green	340		
Standing dead			
Sound	66	245 to	118
Rotten	1,409	101 to	858
Down			
Sound	78	317 to	172
Rotten	1,719	616 to	1,380
Total	7,318	5,206 to	7,038
	(512)	(365 to	493)

Table 2.--*Preharvest volumes by component for shelterwood units, ft³/acre (m³/ha)*

Block	Component	Treatment[1] 1	2	3	4
11	Standing				
	Green	5,651 (395)	3,663 (256)	4,059 (284)	3,414 (239)
	Sound dead	382 (27)	191 (13)	67 (5)	33 (2)
	Unsound dead	0	0	448 (31)	388 (27)
	Down				
	Sound	43 (3)	32 (2)	88 (6)	16 (1)
	Unsound	769 (54)	87 (76)	1,200 (84)	1,429 (100)
	Totals	6,845 (479)	4,973 (348)	5,862 (410)	5,280 (369)
21	Standing				
	Green	4,330 (303)	2,424 (170)	3,031 (212)	3,867 (271)
	Sound dead	108 (7)	39 (3)	109 (8)	85 (6)
	Unsound dead	965 (65)	495 (35)	146 (10)	280 (20)
	Down				
	Sound	35 (2)	72 (5)	33 (2)	19 (1)
	Unsound	1,282 (90)	1,379 (96)	1,237 (86)	709 (50)
	Totals	6,720 (470)	4,409 (308)	4,556 (319)	4,960 (347)

[1]See definition under Description of the Study.

Table 3.--*Preharvest volumes by component for group selection units, ft³/acre (m³/ha)*

Block	Component	Treatment[1] 1	2	3	4
12	Standing				
	Green	6,181 (432)	4,502 (315)	3,297 (231)	4,650 (325)
	Sound dead	10 (1)	25 (2)	16 (1)	21 (1)
	Unsound dead	2,272 (159)	1,206 (84)	2,854 (200)	3,212 (225)
	Down				
	Sound	33 (2)	20 (1)	105 (7)	73 (5)
	Unsound	845 (59)	1,275 (89)	1,982 (139)	1,963 (137)
	Totals	9,341 (654)	7,028 (492)	8,254 (577)	9,919 (694)
22	Standing				
	Green	3,846 (269)	6,478 (453)	4,572 (320)	6,661 (466)
	Sound dead	0	151 (11)	31 (2)	84 (6)
	Unsound dead	2,846 (199)	6,515 (456)	1,399 (98)	1,802 (127)
	Down				
	Sound	33 (2)	177 (2)	75 (5)	25 (2)
	Unsound	1,579 (110)	1,570 (110)	1,493 (104)	1,643 (115)
	Totals	8,304 (581)	14,891(1 042)	7,570 (530)	10,215 (715)

[1]See definition under Description of the Study.

Table 4.--*Preharvest volumes by component for clearcut units, ft³/acre (m³/ha)*

Block	Component	Treatment[1] 1	2	3	4
13	Standing				
	Green	3,538 (247)	3,652 (253)	2,468 (173)	4,094 (28
	Sound dead	5	12 (1)	1	5
	Unsound dead	1,857 (128)	1,086 (76)	789 (55)	1,012 (7
	Down				
	Sound	323 (23)	143 (10)	132 (9)	48 (
	Unsound	2,451 (171)	1,811 (127)	2,523 (176)	1,752 (12
	Totals	8,154 (570)	6,704 (469)	5,913 (414)	6,911 (48
23	Standing				
	Green	4,136 (289)	3,720 (260)	1,717 (120)	3,169 (22
	Sound dead	51 (4)	90 (6)	29 (2)	42 (
	Unsound dead	1,378 (96)	1,545 (108)	715 (50)	630 (4
	Down				
	Sound	133 (9)	59 (4)	43 (3)	108 (
	Unsound	3,123 (218)	2,641 (185)	3,034 (212)	2,484 (17
	Totals	8,821 (617)	8,055 (564)	5,538 (387)	6,433 (45

[1]See definition under Description of the Study.

Nearly half the total volume of wood in the Coram study site is dead material, with a high proportion (over 25 percent) being down material, mostly rotten. In addition, a large proportion of the green material is in small trees and tops not normally utilized in ordinary sawing operations. This means that in a typical stand one-half or more of the volume represent a new utilization potential or a residue management problem when the stand is harvested.

Tree Species

The species composition of the stand also reflects the stand conditions. Western larch along with Douglas-fir are the oldest and largest trees at Coram, but as the stand has developed, the larch, being intolerant of shade, has virtually disappeared from the understory. Alpine fir (*Abies lasiocarpa* [Hook.] Nutt.) and Engelmann spruce (*Picea engelmannii* Parry), both shade-tolerant species, and Douglas-fir make up most of the smaller trees, along with occasional western redcedar (*Thuja plicata* Donn.) and western hemlock (*Tsuga heterophylla* [Raf.] Sarg.). In total, there were about 1,282 stems per acre (519/ha), with 111 stems per acre 7 inches (17.8 cm) d.b.h. or larger (table 5). A detailed stand summary is provided in table 6.

Douglas-fir accounts for 58 percent of the volume. Western larch totals 20 percent, even though there are more spruce and alpine fir stems per acre than larch. In all species, one-third to one-half of the volume is rotten material (fig. 2). Very little of the dead material was sound enough to be utilized for products.

Table 5.--*Number of preharvest stems per acre (per ha), by species and d.b.h. class*

D.b.h. class	Species[1]					
	DF	WL	AF	ES	Other	Total
Inches						
<1	167	2	492	58	26	745
2 to 6	207	25	115	71	8	426
8 to 12	31	1	28	9	5	74
14 to 20	18	4	2	3	1	28
over 20	5	5	--	--	0	10
Total	428 (1,057)	37 (91)	637 (1,573)	141 (348)	40 (99)	1,283 (3,169)

[1]Abbreviations: DF = Douglas-fir
WL = western larch
AF = alpine fir
ES = Engelmann spruce

Table 6.--*Number of preharvest stems per acre (per ha), by diameter class and species*

Diameter class	Species[1]									
	WP	WL	DF	WH	WRC	LP	ES	AF	Other	Total
Inches										
<1	3.9	2.0	166.9	18.5	3.3	0.2	58.1	492.1	0	745.0
2	.2	13.3	124.0	2.0	0	.4	39.8	57.1	0	236.8
4	.2	7.2	54.8	1.4	0.1	1.4	20.6	36.5	0	122.2
6	.3	4.2	27.8	1.5	0	1.5	10.9	20.8	0	67.0
Subtotal	4.6 (11.4)	26.7 (65.9)	373.5 (922.5)	23.4 (57.8)	3.4 (8.4)	3.5 (8.6)	129.4 (319.6)	606.5 (1,498.1)	0	1,171.0 (2,892.4)
8	0	0.8	16.9	.2	0	1.7	3.9	17.9	0	41.4
10	0.3	.3	10.5	†	†	.5	1.7	5.9	†	19.2
12	.2	.3	4.4	†	†	.6	3.0	4.2	0.1	12.8
14	.1	.6	6.7	†	†	.2	1.4	1.5	†	10.5
16	.1	.8	5.0	.1	†	.1	.9	.4	†	7.4
18	.1	1.5	3.4	0	†	0	.4	.1	0	5.5
20	†	1.5	2.9	0	0	0	.2	†	0	4.6
22	0	2.0	2.0	0	0	0	.1	†	0	4.1
24	†	1.3	1.2	0	0	0	.1	†	0	2.6
26	0	.8	.7	0	†	0	†	0	0	1.5
28	0	.4	.5	0	0	0	†	0	0	.9
30	0	.2	.3	0	0	0	†	0	0	.5
30+	0	.1	.3	0	0	0	0	0	†	.4
Subtotal	0.8 (2.0)	10.6 (26.2)	54.8 (135.4)	0.3 (0.7)	†	3.1 (7.7)	11.7 (28.9)	30.0 (74.1)	0.2 (0.5)	111.5 (275.4)
Grand total	5.4 (13.3)	37.3 (92.1)	428.3 (1 057.9)	23.7 (58.5)	3.4 (8.4)	6.6 (16.3)	141.1 (348.5)	636.5 (1 572.2)	0.2 (0.5)	1,282.5 (3 167.8)

†Averages less than 0.1 tree/acre.
[1]Species abbreviations: WP = western white pine
WL = western larch
DF = Douglas-fir
WH = western hemlock
WRC = western redcedar
LP = lodgepole pine
ES = Engelmann spruce
AF = alpine fir

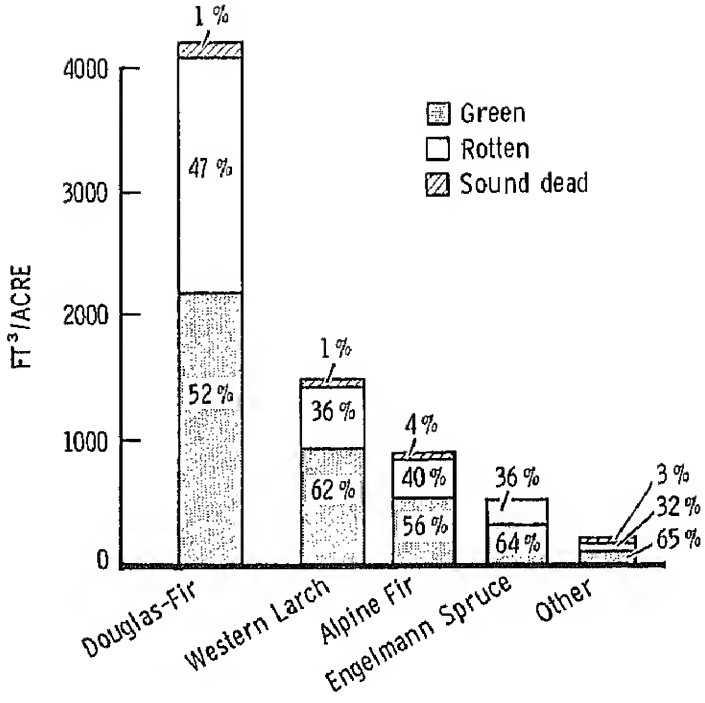

Figure 2.--Preharvest volume per acre of wood of 3.0-inch (7.62-cm) diameter and larger, by species and condition, Coram study units.

Material less than 3.0 Inches (7.62cm) Diameter

In addition to the volume of wood standing and down, the smaller woody material is also an important part of the woody biomass, and is of particular interest to those concerned with fuels, nutrients, microclimate, and microsites for various species of fauna.

MATERIAL 0 TO 3 INCHES (0 TO 7.62 CM) ON THE GROUND

Woody material under 3 inches (7.62 cm) on the ground prior to harvest averaged 4 tons per acre (9 t/ha), ovendry weight. Material in the 1- to 3-inch (2.54- to 7.62-cm) size class accounts for an average of 52 percent of the weight, with the 0 to 1/4-inch (0 to 0.63-cm) size class accounting for 11 percent (table 7). Detailed summary of this material is provided in table 8.

Table 7.--*Weight of woody material <3 inches, crowns, litter, and duff, tons/acre (t/ha)*

Component	Fines	Woody material			Total
		0 - 1/4 inch	1/4 - 1 inch	1 - 3 inches	
Duff	33.22(74.4)	--	--	--	33.22(74.4)
Litter	1.60(3.6)	--	--	--	1.60(3.6)
Wood on ground	--	0.45(1.0)	1.48(3.1)	2.16(4.8)	4.09(9.2)
Tree crowns	5.12(11.5)	3.17(7.1)	4.95(11.1)	4.42(9.9)	17.70(39.7)
Total	39.94(89.5)	3.62(8.1)	6.43(14.2)	6.58(14.7)	56.61(126.9)

Table 8.--*Weight of small preharvest woody material on ground, by diameter class, tons/acre (t/ha)*

Treatment[2]	Size	Block[1] 11(SH)	12(GS)	13(CC)	21(SH)	22(GS)	23(CC)	Average
	Inches							
1 (IT)	0-1/4	0.43	0.37	0.33	0.55	0.47	0.33	0.41
	1/4-1	1.22	1.19	1.39	1.10	1.87	1.36	1.35
	1-3	2.46	1.72	1.50	1.80	1.95	3.37	2.13
	Total	4.11	3.28	3.22	3.45	4.29	5.06	3.90
		(9.21)	(7.35)	(7.22)	(7.73)	(9.61)	(11.34)	(8.73)
2 (SL)	0-1/4	0.28	0.72	0.42	0.44	0.34	0.63	0.47
	1/4-1	.83	1.84	1.17	1.90	1.25	1.93	1.49
	1-3	1.73	2.02	1.87	3.38	2.08	2.27	2.22
	Total	2.84	4.58	3.46	5.72	3.67	4.83	4.18
		(6.36)	(10.26)	(7.75)	(12.82)	(8.22)	(10.82)	(9.37)
3 (NC)	0-1/4	0.42	0.50	0.49	0.44	0.54	0.31	0.45
	1/4-1	1.55	1.29	1.24	1.09	1.68	1.33	1.36
	1-3	2.71	1.69	2.09	1.76	2.64	1.43	2.06
	Total	4.68	3.48	3.82	3.29	4.86	3.07	3.87
		(10.49)	(7.80)	(8.56)	(7.37)	(10.89)	(6.88)	(8.67)
4 (IL)	0-1/4	0.47	0.60	0.48	0.57	0.39	0.44	0.49
	1/4-1	1.92	1.25	1.49	2.97	1.13	1.57	1.72
	1-3	2.68	1.79	2.33	1.45	3.24	1.61	2.19
	Total	5.07	3.64	4.30	4.99	4.76	3.62	4.40
		(11.36)	(8.16)	(9.64)	(11.18)	(10.67)	(8.11)	(9.86)
Block averages		4.18 (9.37)	3.75 (8.4)	3.70 (8.29)	4.36 (9.77)	4.40 (9.86)	4.15 (9.30)	4.09 (9.17)

[1]See definition of blocks under Description of the Study.
[2]See definition of treatments under Description of the Study.

CROWN WEIGHT

The total crown weight of standing trees averaged about 18 tons per acre (40 t/ha). Foliage accounts for a substantial portion of this. The crown weights ranged from 9 to 25 tons per acre (20 to 56 t/ha) among the various subtreatment units. The detailed data are shown in table 9.

DUFF AND LITTER

Estimates of the duff and litter weights were made prior to harvesting, using procedures described by Brown (1974). Duff consists of organic material above the mineral soil level that has decomposed to where individual particles are not identifiable. Litter is newly fallen material that has not decomposed. These components do not enter into wood removal, but are of interest for appraising fuel and nutrient conditions.

Weight of the duff averaged 38.22 tons/acre (86 t/ha) (table 7) and varied between 32 and 53 tons/acre (72 to 119 t/ha) among treatments. The weight was estimated by measuring duff depth and converting on a basis of 14.5 tons/acre per 1 inch of depth. This corresponds to a specific gravity of 0.13.

Table 9.--*Crown weights of standing trees, preharvest, tons/acre (t/ha)*

Treatment[2]	Size	Block[1] 11(SH)	12(GS)	13(CC)	21(SH)	22(GS)	23(CC)	Treatment average
	Inches							
1 (IT)	Foliage	6.2	6.7	4.6	5.1	4.2	4.6	5.2
	0-1/4	3.8	4.2	2.7	3.3	2.6	2.8	3.2
	1/4-1	5.7	6.6	3.9	5.3	4.1	4.5	5.0
	1-3	6.1	6.1	3.3	4.6	3.2	3.1	4.1
	Total	21.8	23.6	14.5	18.3	14.1	15.0	17.9
		(48.9)	(52.9)	(32.5)	(41.0)	(31.6)	(33.6)	(40.1)
2 (SL)	Foliage	4.4	4.4	4.4	4.9	4.2	5.6	4.7
	0-1/4	2.7	2.7	2.7	3.1	4.2	3.4	3.1
	1/4-1	3.9	4.6	3.9	4.8	6.7	5.5	4.9
	1-3	4.1	3.7	3.8	4.1	8.1	4.5	4.7
	Total	15.1	15.4	14.8	16.8	23.2	19.0	17.4
		(33.8)	(34.5)	(33.2)	(37.9)	(52.0)	(42.6)	(39.0)
3 (NC)	Foliage	4.7	6.3	3.6	6.0	6.6	2.8	5.0
	0-1/4	3.0	3.7	2.2	3.5	4.0	1.7	3.0
	1/4-1	4.7	5.6	3.6	5.0	6.5	2.7	4.7
	1-3	5.8	5.9	3.1	4.9	4.4	1.9	4.3
	Total	18.2	21.5	12.5	19.4	21.5	9.1	17.0
		(40.8)	(48.2)	(28.0)	(43.5)	(48.2)	(20.4)	(38.1)
4 (IL)	Foliage	4.7	6.1	4.1	6.1	7.6	5.0	5.6
	0-1.4	2.8	3.6	2.6	3.8	4.5	3.0	3.4
	1/4-1	4.0	4.8	3.6	5.5	7.5	4.5	5.2
	1-3	4.3	4.8	3.4	5.5	5.0	2.9	4.3
	Total	15.8	20.8	13.7	20.9	24.6	15.4	18.5
		(35.4)	(46.6)	(30.7)	(46.8)	(55.1)	(34.5)	(41.5)
Block averages		17.7 (39.7)	20.3 (45.5)	13.9 (31.1)	18.9 (42.4)	20.9 (46.8)	14.6 (32.7)	17.7 (39.7)

[1]See block definitions under Description of the Study.
[2]See treatment definitions under Description of the Study.

The litter weights averaged 1.6 tons/acre (3.6 t/ha) (table 7), and varied from 1.2 tons/acre (2.7 t/ha) to 2.2 tons/acre (4.9 t/ha). Litter weight was estimated by measuring depth and converting to weight on the basis of 1.3 lb/ft^3 (20.8 kg/m^3) of undisturbed litter. Detailed summaries by unit for duff and litter are in tables 11-14 (appendix).

TOTAL WEIGHT

The total of all material less than 3 inches is over 56 tons/acre (127 t/ha). The weight of standing and down woody material over 3 inches is approximately 85 tons/acre (190 t/ha) assuming about 24 lb/ft^3 ovendry weight of wood (sound wood will weigh more that this, rotten wood less). The total weight is about 141 tons/acre (316 t/ha) (fig. 3).

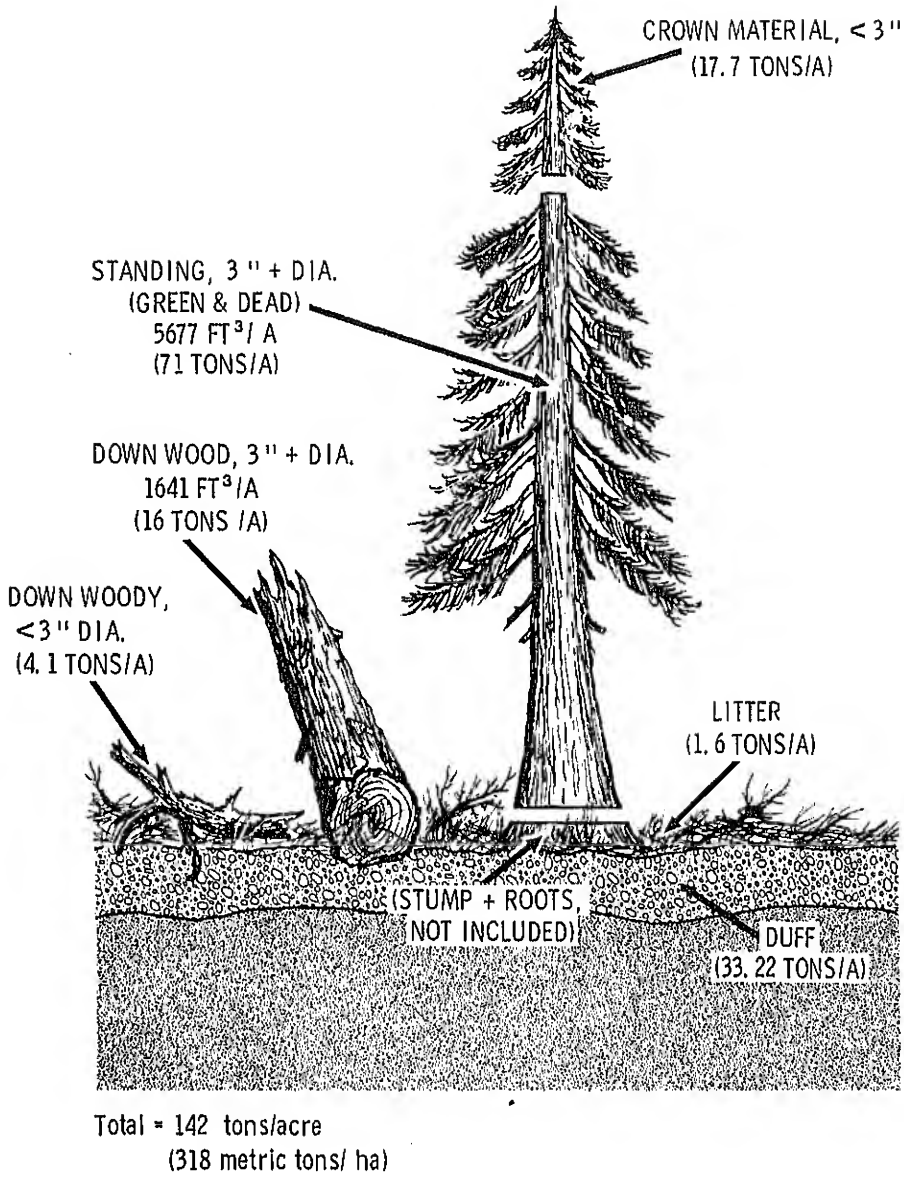

Figure 3.--Average preharvest volume and weight of various forest components, Coram study area.

POSTHARVEST CHANGES IN WOODY MATERIAL

The amount of woody material that remains as residue after harvesting depends on the cutting prescription and the level of utilization specified, and also on the extent to which utilization specifications are followed during logging. Residue volume is also related to preharvest conditions and these vary widely among cutting units and subtreatments. If residues are expressed as a percentage of volumes, however, this variation can be removed to show more clearly the effects of cutting and utilization.

ne of Residues 3.0 Inches (7.62 cm) Diameter and Larger

ı on the four utilization treatments specified, we would expect residues remaining vest to be arrayed as follows, from most to least:

Conventional saw log utilization,
Intensive tree utilization, understory slashed,
Intensive log utilization, understory protected,
Near-complete removal.

volume of residues that remained after logging averaged from 873 ft^3/acre (61 m^3/ha) elterwood-near complete utilization treatment to 2,950 ft^3/acre (206 m^3/ha) in the conventional saw log utilization treatment (table 10). In general, the total volume es follows the expected pattern, but there were substantial differences in the pre-tand that affect volume of residues. (See detailed summary in tables 15-20 [appendix].)

--*Volume of postharvest residues by cutting method and utilization treatment, ft^3/acre (m^3/ha)*

g	Conventional saw log utilization	Intensive tree utilization	Intensive log utilization	Near-complete utilization
od				
	476	314	83	29
ead	412	252	126	98
	1,049	733	1,295	746
	1,937	1,299	1,504	873
	(135)	(91)	(105)	(61)
ection				
	877	506	168	66
ead	246	112	139	101
	827	1,286	858	796
	1,950	1,904	1,165	963
	(136)	(133)	(81)	(67)
	415	186	95	37
ead	614	390	149	134
	1,929	1,483	1,428	1,301
	2,958	2,059	1,672	1,472
	(206)	(144)	(117)	(103)

otal volume of residue expressed as a percent of total preharvest volume is illus-figure 4. Here the proportion of the total preharvest stand left as residues decreases as the level of utilization increases. The relationship is somewhat owever, because of the large and variable volume of rotten material.

sound residues are compared to sound preharvest volume, however, there is a consis-mooth trend (fig. 5). Sound residues in conventional saw log utilization were as percent of the preharvest sound volume in shelterwood units. In contrast, sound ere less than 10 percent in the near-complete utilization treatment in all cutting

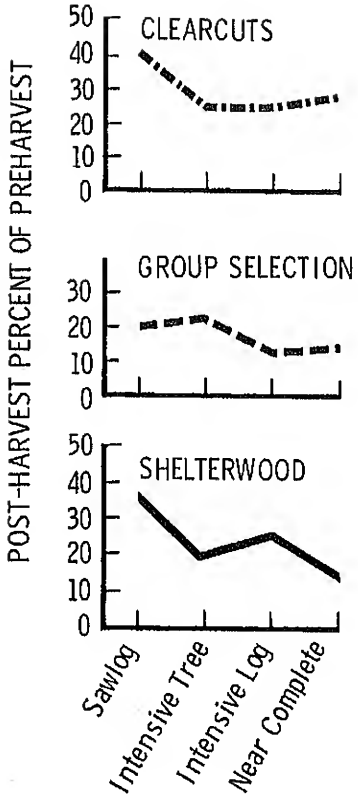

Figure 4.--Total residue as a percent of total preharvest volume.

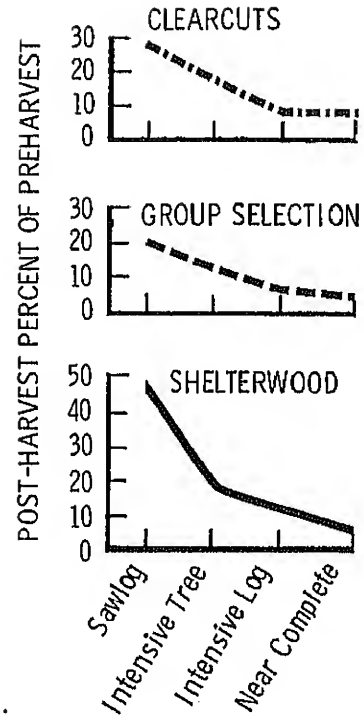

Figure 5.--Sound residue volume as percent of sound preharvest volume.

From the standpoint of utilization of wood fiber, figure 5 indicates that conventional saw log utilization leaves a substantial volume of sound material, but there was not much difference in the proportion of sound residues among the three more intensive treatments. There also was a lower proportion of sound residues in the shelterwood units than in the group selection and clearcut units. This was probably because protection of leave trees made it more difficult to remove sound pieces that might have been taken in clearcut units.

Although some sound material remained in all units, some unsound material was also removed, even in treatments where it was not required. In the clearcut and group selection units, the volume removed ranged from about 15 percent to over 100 percent more than the estimated sound volume. A considerable amount of unsound material was removed.

To some extent this was expected since in some treatments utilization specifications required removal of pieces that were one-third or more sound. Also, a good market for pulp chips at the time contributed to removal of defective material.

Characteristics of Residues

The utilization potential of the residues depends in part on the number and size of residue pieces and on their condition.

The total number of pieces remaining after logging averaged from about 411/acre (1,015/ha) in shelterwood near-complete utilization to 1,240/acre (3,063/ha) in group selection with intensive tree utilization. The total number of pieces per acre of residue is tabulated below.

	Conventional saw log utilization	Intensive tree utilization	Intensive log utilization	Near-complete utilization
Shelterwood	763	825	471	411
Group selection	904	1,240	690	580
Clearcut	932	1,043	864	677

As might be expected, fewest pieces were left in the near-complete treatment. There was not much difference between near-complete and intensive log utilization because in the intensive log treatment, the understory was not slashed. Conventional saw log utilization usually had fewer pieces than the intensive tree utilization treatment, probably because in bucking to required sizes in intensive treatment utilization, some additional residue pieces were created.

Many of these pieces were too small, in length or diameter, or were not sound enough to be used. There were, however, some potentially usable pieces. The tabulation below shows the number of individual sound pieces[1] per acre that could have been derived from the residues:

	Conventional saw log utilization	Intensive tree utilization	Intensive log utilization	Near-complete utilization
Shelterwood	257	129	50	20
Group selection	338	245	91	63
Clearcut	112	88	59	27

Residues Less than 3.0 Inches (7.62 cm) Diameter

The amount of fine residues under 3.0 inches diameter about doubled after harvest. The actual weights ranged from 6.44 tons to 13.49 tons per acre (16 to 33 t/ha) as shown below:

	Conventional saw log utilization	Intensive tree utilization	Intensive log utilization	Near-complete utilization
Shelterwood	10.22	9.26	9.45	6.44
Group selection	11.01	13.49	12.13	8.30
Clearcut	10.97	9.55	10.20	8.24

On an actual weight basis, there does not appear to be much difference among treatments except for near-complete removal, where whole trees were removed. The amount of fine residues, however, is determined in large part by preharvest conditions. In figure 6, the increases in fine residues are plotted for each utilization treatment by block. In general, shelterwood had less increase in weight and the near-complete utilization treatment less increase in fine material than the other treatments because small stems were removed, not left as slash. Generally, however, there is not a strong relationship of fine residues to utilization treatment.

No postharvest measurements were made of duff and litter. This material is pushed around during logging, but does not change in amount. As needles dry and fall from slash, presumably there will be some increase in litter weight.

The role of duff and litter in regeneration following logging is discussed in other reports.

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[1]Estimated as number of sound pieces 8 feet or more long (2.4 m) and over 3 inches (7.62 cm) small end.

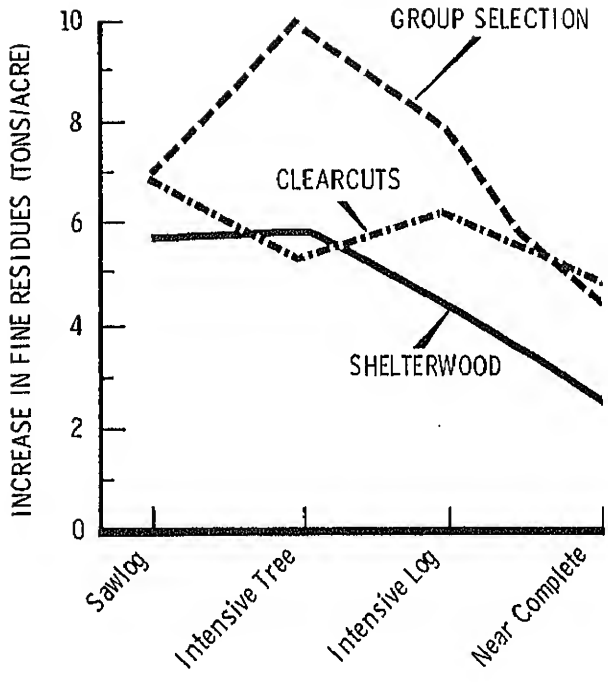

Figure 6.--Increase in fine postharvest residues < 3.0 inches diameter (7.62 cm).

SUMMARY AND CONCLUSIONS

The total preharvest volume of wood 3 inches diameter (7.62 cm) and larger on the units logged in the Coram study averaged 7,318 ft^3/acre (512 m^3/ha). About 57 percent of this was live green material, and over 40 percent was unsound (table 21, appendix). The material less than 3 inches (crowns, litter, duff) averaged about 56.6 tons/acre (127 t/ha). Because of the patchy nature of the forest, these weights and volumes varied widely among cutting units and utilization treatments.

Despite this wide variation, the amount of residue material remaining after logging was related to the utilization level. Under conventional saw log utilization (the least intensive of the utilization treatments), from 20 percent to over 40 percent of the sound material remained, but under near-complete utilization, less than 10 percent of the sound material remained. On the more intensive utilization treatments most of the sound material was too small to be used.

Measurements were made of all phases, which provide a detailed picture of various components in the woody biomass of an overmature Douglas-fir/larch forest, showing how these components changed under different cutting methods and utilization levels.

The study indicates that despite great variation in preharvest stand conditions, the amount and kinds of residue remaining can be influenced by the utilization level prescribed. The impact of these different levels of residue on other physical and biological systems, such as soil nutrients, hydrology, and regeneration, is being followed through a series of other Coram studies.

The variations in woody material at the Coram site are probably typical of fir/larch forests throughout the Northern Rockies. Therefore, while there may not be other cutting units exactly like those at Coram, these data should provide managers with a useful insight of the composition of the woody material and changes occurring from logging under similar circumstances.

Various sampling schemes and measurement methods were used in estimating the preharvest and postharvest components reported here. Percent errors (the sample standard error divided by the sample mean, expressed as a percent) for all samples were quite low (tables 22, 23, appendix). To achieve a similar percent error in the individual subtreatment units, a much more intensive sampling scheme would be required.

PUBLICATIONS CITED

Artley, Donald K., Raymond Shearer, and Robert W. Steele.
1978. Effects of burning moist fuels on seedbed preparation in cutover western larch forests. USDA For. Serv. Res. Pap. INT-211, 14 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Brown, James K.
1974. Handbook for inventorying downed woody material. USDA For. Serv. Gen. Tech. Rep. INT-16, 24 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Brown, James K.
1978. Weight and density of Rocky Mountain conifers. USDA For. Serv. Res. Pap. INT-197, 56 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Brown, James K., J. A. Kendall Snell, and David L. Bunnell.
1977. Handbook for predicting slash weight of western conifers. USDA For. Serv. Gen. Tech. Rep. INT-37, 35 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

APPENDIX

Table 11.--*Weight of litter on ground, preharvest,*[1] *tons/acre (t/ha)*

Block[3]	Treatment[2] 1 IT	2 SL	3 NC	4 IL	5 Control	Average
11 SH	1.44	1.65	1.01	1.27		1.34 (3.00)
12 GS	1.56	2.24	1.79	1.98		1.89 (4.23)
13 CC	1.39	1.53	1.04	2.12		1.52 (3.41)
14 Control					1.56	1.56 (3.50)
21 SH	1.30	1.63	1.79	1.39		1.53 (3.43)
22 GS	2.34	2.27	2.12	2.03		2.19 (4.91)
23 CC	0.97	1.42	1.60	0.71		1.18 (2.64)
24 Control					1.63	1.63 (3.65)

[1]Based on 1.3 lb/ft^3 (20.8 kg/m^3) of undisturbed forest litter.
[2]See definition of treatments under Description of the Study.
[3]See definition of blocks under Description of the Study.

Table 12.--*Average litter depth, preharvest, inches (cm)*

Block[2]	Treatment[1] 1 IT	2 SL	3 NC	4 IL	5 Control
11 SH	0.61 (1.55)	0.70 (1.78)	0.43 (1.09)	0.54 (1.37)	
12 GS	.66 (1.68)	.95 (2.41)	.76 (1.93)	.84 (2.13)	
13 CC	.59 (1.50)	.65 (1.65)	.44 (1.12)	.90 (2.29)	
14 Control					0.66 (1.68)
21 SH	.55 (1.40)	.69 (1.75)	.76 (1.93)	.59 (1.50)	
22 GS	.99 (2.51)	.96 (2.44)	.90 (2.29)	.86 (2.18)	
23 CC	.41 (1.04)	.60 (1.52)	.68 (1.73)	.30 (.76)	
24 Control					.69 (1.75)

[1]See definition of treatments under Description of the Study.
[2]See definition of blocks under Description of the Study.

Table 13.--*Weight of duff on ground, preharvest,*[1] *tons/acre (t/ha)*

Block[3]	Treatment[2] 1 IT	2 SL	3 NC	4 IL	5 Control	Average
11 SH	43.10	33.69	30.98	46.80		38.64 (86.59)
12 GS	37.68	30.64	53.09	32.96		38.59 (86.48)
13 CC	39.95	50.36	51.92	41.60		45.96 (103.0)
14 Control					28.17	28.17 (63.13)
21 SH	37.27	45.79	41.45	41.02		41.38 (92.63)
22 GS	49.63	39.54	37.53	38.79		41.37 (92.71)
23 CC	33.11	39.37	50.02	43.51		41.50 (93.00)
24 Control					30.18	30.18 (67.63)

[1]Based on ovendry weight of 14.5 tons/inch (82.54 t/cm) depth of duff (this corresponds with a specific gravity of 0.13).
[2]See definition of treatments under Description of the Study.
[3]See definition of blocks under Description of the Study.

Table 14.--*Average duff depth, preharvest, inches (cm)*

Block[2]	Treatment[1] 1 IT	2 SL	3 NC	4 IL	5 Control
11 SH	2.97 (7.54)	2.32 (5.89)	2.13 (5.41)	3.22 (8.18)	
12 GS	2.59 (6.58)	2.11 (5.36)	3.66 (9.30)	2.27 (5.77)	
13 CC	2.75 (6.98)	3.47 (8.81)	3.58 (9.09)	2.86 (7.26)	
14 Control					1.94 (4.93)
21 SH	2.57 (6.63)	3.15 (8.00)	2.85 (7.24)	2.82 (7.16)	
22 GS	3.42 (8.69)	2.72 (6.91)	2.58 (6.55)	2.67 (6.78)	
23 CC	2.28 (5.79)	2.71 (6.88)	3.44 (8.74)	3.00 (7.62)	
24 Control					2.08 (5.28)

[1]See definition of treatments under Description of the Study.
[2]See definition of blocks under Description of the Study.

Table 15.--*Postharvest volumes by component for shelterwood units, ft³/acre (m³/ha)*

Block	Component	Treatment[1] 1 IT		2 SL		3 NC		4 IL	
11	Standing green								
	Leave trees	2,526	(177)	1,598	(112)	1,724	(21)	1,619	(113)
	Other	31	(2)	10	(1)	0		280	(20)
	Down green								
	Sound	422	(29)	542	(38)	34	(2)	61	(4)
	Unsound	34	(2)	13	(1)	0		1	
	Down dead								
	Sound	253	(18)	484	(34)	80	(6)	69	(5)
	Unsound	583	(41)	1,023	(71)	925	(65)	1,617	(113)
	Totals	3,849	(269)	3,670	(257)	2,763	(193)	3,647	(255)
21	Standing green								
	Leave trees	1,922	(134)	1,962	(37)	1,201	(84)	1,839	(129)
	Other	19	(1)	0		2		694	(48)
	Down green								
	Sound	205	(14)	410	(29)	24	(2)	105	(7)
	Unsound	18	(1)	53	(4)	1		3	
	Down dead								
	Sound	251	(18)	341	(24)	116	(8)	183	(13)
	Unsound	1,448	(101)	1,010	(71)	566	(40)	969	(68)
	Totals	3,863	(270)	3,777	(264)	1,910	(134)	3,793	(265)

[1]See definition of treatments under Description of the Study.

Table 16.--*Postharvest volumes by component for group selection units, ft^3/acre (m^3/ha)*

Block	Component	Treatment[1] 1 IT		2 NC		3 SL		4 IL	
12	Standing green	1		0		0		154	(11)
	Down green								
	Sound	639	(45)	682	(48)	59	(4)	238	(17)
	Unsound	23	(2)	6		0		4	
	Down dead								
	Sound	65	(4)	237	(16)	57	(4)	176	(12)
	Unsound	1,027	(72)	338	(24)	483	(34)	740	(52)
	Totals	1,755	(123)	1,263	(88)	599	(42)	1,312	(92)
22	Standing green	34	(2)	0		0		31	(2)
	Down green								
	Sound	374	(26)	1,072	(75)	74	(5)	99	(7)
	Unsound	7		5		0		0	
	Down dead								
	Sound	160	(11)	255	(18)	146	(10)	103	(7)
	Unsound	1,515	(106)	1,305	(91)	1,109	(78)	973	(68)
	Totals	2,090	(146)	2,637	(184)	1,329	(93)	1,206	(84)

[1]See definition of treatments under Description of the Study.

Table 17.--*Postharvest volumes by component for clearcut units, ft³/acre (m³/ha)*

Component	Treatment[1] 1 IT		2 SL		3 NC		4 IL	
Standing green	0		0		0		26	(2)
Down green								
Sound	146	(10)	499	(35)	25	(2)	149	(10)
Unsound	0		101	(7)	4		0	
Down dead								
Sound	298	(21)	512	(36)	135	(9)	166	(12)
Unsound	1,284	(90)	1,269	(89)	787	(55)	675	(47)
Totals	1,728	(121)	2,381	(167)	951	(66)	1,016	(71)
Standing green	43	(3)	0		10	(1)	42	(3)
Down green								
Sound	226	(16)	331	(23)	49	(3)	42	(3)
Unsound	0		68	(5)	0		0	
Down dead								
Sound	483	(34)	716	(50)	134	(9)	132	(9)
Unsound	1,682	(118)	2,421	(169)	1,812	(127)	2,182	(153)
Totals	2,434	(170)	3,536	(247)	2,005	(140)	2,398	(168)

[1]See definition of treatments under Description of the Study.

16.--*Total volume per acre (hectare) of standing and down wood, 3-inch (7.62-cm) diameter and larger, preharvest and postharvest, and volume removed, by block and treatment, ft³/acre (m³/ha)*

Block	Number	Treatment: Intensive tree utilization 5-inch d.b.h. 1	Conventional saw log utilization 7-inch d.b.h. 2	Near-complete removal 3	Intensive log utilization 7-inch d.b.h. 4
		Preharvest			
terwood	11	6,845 (480)	4,973 (348)	5,862 (410)	5,280 (369)
terwood	21	6,720 (470)	4,409 (308)	4,556 (319)	4,960 (347)
p Selection	12	9,341 (654)	7,028 (492)	8,254 (577)	9,919 (694)
p Selection	22	8,304 (581)	14,891 (1,042)	7,570 (530)	10,215 (715)
rcut	13	8,154 (570)	6,704 (469)	5,913 (414)	6,911 (484)
rcut	23	8,821 (617)	8,055 (563)	5,538 (387)	6,433 (450)
		Postharvest			
terwood	11	3,849 (269)	3,670 (257)	2,763 (193)	3,647 (255)
terwood	21	3,863 (270)	3,777 (264)	1,910 (134)	3,793 (265)
p Selection	12	1,755 (123)	1,263 (88)	599 (42)	1,312 (92)
p Selection	22	2,090 (146)	2,637 (184)	1,329 (93)	1,206 (84)
rcut	13	1,728 (121)	2,381 (167)	951 (66)	1,016 (71)
rcut	23	2,434 (170)	3,536 (247)	2,005 (140)	2,398 (168)
		Volume Removed			
terwood	11	2,996 (210)	1,303 (91)	3,099 (217)	1,633 (114)
terwood	21	2,857 (200)	632 (44)	2,646 (185)	1,167 (82)
p Selection	12	7,586 (531)	5,765 (403)	7,655 (536)	8,607 (602)
p Selection	22	6,214 (435)	12,254 (857)	6,241 (437)	9,009 (630)
rcut	13	6,426 (450)	4,323 (302)	4,962 (347)	5,895 (412)
rcut	23	6,387 (447)	4,519 (316)	3,533 (247)	4,035 (282)

Table 19.--*Crown weights on standing trees, postharvest (prior to slash burning in treatments 1 and 2), tons/acre (t/ha)*

Treatment[2]	Size	Block[1] 11 SH	12 GS	13 CC	21 SH	22 GS	23 CC	Treatment averages
	Inches							
1 IT	Foliage	2.4	0.01		2.2	0.2		
	0-1/4	1.5	.01		1.4	.1		
	1/4-1	2.4	.01		2.2	.1		
	1-3	1.6	.04		.9	.1		
	Total	7.9	0.07		6.7	0.5		2.5
		(17.7)	(0.16)		(15.0)	(1.1)		(5.6)
2 SL	Foliage	1.3			1.9			
	0-1/4	.8			1.2			
	1/4-1	1.4			2.0			
	1-3	.8			1.1			
	Total	4.3			6.2			1.7
		(9.6)			(13.9)			(3.8)
3 NC	Foliage	1.7	0.02	0.02	1.8		0.1	
	0-1/4	1.1	.01	0	1.0		.1	
	1/4-1	1.9	.01	.01	1.7		.1	
	1-3	1.0	.01	.03	.9		.1	
	Total	5.7	0.05	0.06	5.4		0.4	1.9
		(12.8)	(0.11)	(0.13)	(12.1)		(0.9)	(4.3)
4 IL	Foliage	3.1	0.5	0.4	4.8	0.3	0.3	
	0-1/4	1.9	.4	.2	3.0	.2	.2	
	1/4-1	2.6	.5	.2	4.2	.2	.2	
	1-3	2.8	1.0	.3	3.4	.3	.3	
	Total	10.4	2.4	1.1	15.4	1.0	1.0	5.2
		(23.3)	(5.4)	(2.5)	(34.5)	(2.2)	(2.2)	(11.7)
Block averages		7.1	0.6	0.3	8.4	0.4	0.3	2.9
		(15.9)	(1.3)	(0.7)	(18.8)	(0.9)	(0.7)	(6.5)

[1]See definition of blocks under Description of the Study.
[2]See definition of treatments under Description of the Study.

Table 20.--*Weight of small woody material on ground, by diameter class, postharvest, tons/acre (t/ha)*

Treatment[1]	Size	Block[2] 11 SH	12 GS	13 CC	21 SH	22 GS	23 CC	Treatment averages
	Inches							
1 IT	0-1/4	1.50	2.10	1.72	1.44	1.95	1.45	
	1/4-1	3.48	6.38	3.24	3.99	5.09	3.74	
	1-3	4.24	7.89	4.51	3.85	3.57	4.45	
	Total	9.22 (20.66)	16.37 (36.68)	9.47 (21.22)	9.28 (20.80)	10.61 (23.78)	9.64 (21.60)	10.77 (24.13)
2 SL	0-1/4	2.03	1.86	2.00	1.43	2.01	2.09	
	1/4-1	3.83	4.80	3.64	3.61	3.59	3.78	
	1-3	5.37	6.10	6.09	4.18	3.67	4.35	
	Total	11.23 (25.17)	12.76 (28.59)	11.73 (26.29)	9.22 (20.66)	9.27 (20.77)	10.22 (22.90)	10.74 (24.07)
3 NC	0-1/4	1.41	1.06	1.05	1.27	1.40	1.25	
	1/4-1	2.05	3.34	5.70	1.75	2.73	1.59	
	1-3	3.60	3.90	3.19	2.81	4.16	3.70	
	Total	7.06 (15.82)	8.30 (18.60)	9.94 (22.27)	5.83 (13.06)	8.29 (18.58)	6.54 (14.66)	7.66 (17.17)
4 IL	0-1/4	1.64	1.65	1.70	1.26	1.94	1.53	
	1/4-1	2.34	4.55	4.46	2.55	3.40	2.15	
	1-3	5.81	5.70	6.25	5.30	7.03	4.32	
	Total	9.79 (21.94)	11.90 (26.68)	12.41 (27.81)	9.11 (20.41)	12.37 (27.72)	8.00 (17.93)	10.60 (23.75)
Block averages		9.33 (20.91)	12.33 (27.63)	10.89 (24.40)	8.36 (18.73)	10.14 (22.72)	8.60 (19.27)	9.94 (22.29)

[1]See definition of treatments under Description of the Study.
[2]See definition of blocks under Description of the Study.

Table 21.--*Preharvest volume components, in percent, for Coram study site*

Component	Block[1] 11 12	11 2	11 3	11 4	12 1	12 2	12 3	12 4	13 1	13 2	13 3	13 4
	Percent (Total volume, ft³/acre)											
Standing												
Green	82.6	73.7	69.2	64.6	66.2	64.1	39.9	46.9	43.4	54.5	41.7	59.2
Sound dead	5.6	3.8	1.1	.6	.1	.4	.2	.2	.1	.2	.0	.0
Unsound	.0	.0	7.6	7.4	24.3	17.2	34.6	32.4	22.5	16.2	13.3	14.6
Down												
Sound	.6	.6	1.5	.3	.3	.3	1.3	.7	4.0	2.1	2.2	.7
Unsound	11.2	21.4	20.5	27.1	9.1	18.1	24.0	19.8	30.1	27.0	42.7	25.3
Total volume	(6,845)	(4,973)	(5,862)	(5,280)	(9,341)	(7,028)	(8,254)	(9,919)	(8,154)	(6,704)	(5,913)	(6,911)

Component	Block 21 1	21 2	21 3	21 4	22 1	22 2	22 3	22 4	23 1	23 2	23 3	23 4	Average all treatments
	Percent (Total volume, ft³/acre)												
Standing													
Green	64.4	55.0	66.5	78.0	46.3	43.5	60.4	65.2	46.9	46.2	31.0	49.3	56.6
Sound dead	.6	.9	2.4	1.7	.0	1.0	.4	.8	.6	1.1	.5	.6	1.0
Unsound	14.4	11.2	3.2	5.6	34.3	43.7	18.5	17.6	15.6	19.2	12.9	9.8	16.5
Down													
Sound	.5	1.6	.7	.4	.4	1.2	1.0	.2	1.5	.7	.7	1.7	1.0
Unsound	19.1	31.3	27.1	14.3	19.0	10.5	19.7	16.1	35.4	32.8	54.8	38.6	24.8
Total volume	(6,720)	(4,409)	(4,556)	(4,960)	(8,304)	(14,891)	(7,570)	(10,215)	(8,821)	(8,055)	(5,538)	(6,455)	(7,314)

[1]See definition of blocks under Description of the Study.
[2]See definition of treatments under Description of the Study.

Table 22.--*Percent errors*[1] *for various preharvest components*

Block-treatment[2]	Number of standing green trees <7"	Number of standing dead trees <7"	Weight of small woody material 0"-1/4"	1/4"-1"	1"-3"	Duff load	Total down volume >3"
	- *Percent errors* -						
	(n=10)	(n=10)		(n=20)		(n=20)	(n=20)
11-1	17.1	23.1	14.5	14.5	17.2	9.8	22.0
2	16.1	21.5	12.4	16.0	25.4	22.4	20.7
3	17.9	29.1	15.7	16.5	24.4	29.7	26.1
4	12.7	24.2	18.8	20.8	25.4	24.2	18.4
12-1	21.0	41.3	9.6	12.2	24.7	36.4	17.0
2	18.8	20.9	10.7	12.0	22.3	49.3	26.4
3	12.3	31.3	11.5	14.1	17.7	29.8	20.0
4	13.8	30.3	11.7	16.9	18.7	58.6	14.3
13-1	17.9	34.0	23.0	21.8	25.1	51.6	18.0
2	15.1	30.6	9.9	16.1	21.6	43.3	23.7
3	15.8	37.3	16.2	11.9	22.6	51.0	17.4
4	16.7	47.5	9.9	18.9	20.1	59.9	22.2
21-1	15.1	24.5	16.4	12.7	26.8	71.8	18.5
2	14.9	29.3	19.8	16.6	17.0	60.6	29.6
3	16.8	37.9	17.7	14.2	18.1	69.6	18.7
4	15.5	17.7	16.4	51.3	30.0	72.4	24.2
22-1	13.8	54.1	14.9	16.0	26.8	64.3	16.3
2	17.5	51.1	14.0	11.5	26.1	83.1	21.8
3	20.4	53.6	14.7	19.0	23.0	89.6	18.6
4	21.6	95.0	15.5	13.0	25.1	88.1	19.3
23-1	15.2	37.1	15.4	15.6	37.2	104.8	14.4
2	21.2	34.6	14.1	18.6	36.4	89.3	15.5
3	29.3	51.1	18.9	25.5	21.7	72.2	15.7
4	27.3	65.8	17.4	17.1	24.4	84.9	20.8
	(n=30)	(n=30)		(n=40)		(n=40)	(n=40)
14-5	14.9	21.2	8.9	15.3	18.8	45.7	14.7
	(n=20)	(n=20)					
24-5	12.2	31.0	10.0	26.0	16.1	62.1	12.2
	(n=290)	(n=290)					(n=558)
All samples	3.7	7.6					4.1

[1]Percent error is the sample standard error divided by the sample mean.
[2]See definition of blocks and treatments under Description of the Study.

Table 23.--*Percent errors*[1] *for various postharvest components*

Block-treatment[2]	Weight of small woody material 0"-1/4"	1/4"-1"	1"-3"	Total down volume >3"
	Percent errors			
		(n=30)		(n=30)
11-1	11.6	11.2	15.4	17.6
2	7.0	12.3	15.0	13.1
3	7.5	10.2	17.0	25.6
4	11.5	16.4	9.5	16.1
12-1	11.2	13.6	11.8	17.8
2	7.4	8.8	16.1	13.2
3	12.0	9.2	15.6	18.2
4	9.4	10.5	12.1	11.5
13-1	9.3	11.1	13.6	15.1
2	9.3	12.0	13.7	15.0
3	7.3	37.4	19.1	13.3
4	17.1	16.0	11.6	15.6
21-1	14.1	14.9	13.6	19.4
2	13.3	14.9	17.4	10.4
3	10.0	13.5	17.9	21.9
4	10.7	14.9	14.3	19.0
22-1	8.8	8.6	13.2	19.2
2	8.7	12.2	15.9	19.8
3	10.2	13.8	15.2	20.7
4	11.9	13.9	13.4	12.1
23-1	12.4	16.1	15.2	17.3
2	8.2	10.6	16.7	13.0
3	12.2	13.9	15.8	18.9
4	11.9	13.7	14.9	17.9
All samples				(n=720) 3.9

[1]Percent error is the sample standard error divided by the sample mean.
[2]See definition for blocks and treatments under Description of the Study.

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Benson, Robert E., and Joyce A. Schlieter.
1980. Volume and weight characteristics of a typical Douglas-fir/western larch stand, Coram Experimental Forest, Montana. USDA For. Serv. Gen. Tech. Rep. INT-92, 28p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

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KEYWORDS: biomass, forest residues, Douglas-fir/western larch

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